Hydroclimate changes in eastern Africa over the past 200,000 years may have influenced early human dispersal

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Supplementary Information for

Hydroclimate changes in eastern Africa over the past 200,000 years may have influenced early human dispersal

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Supplementary Information Text

Supplementary Note 1 for Climate

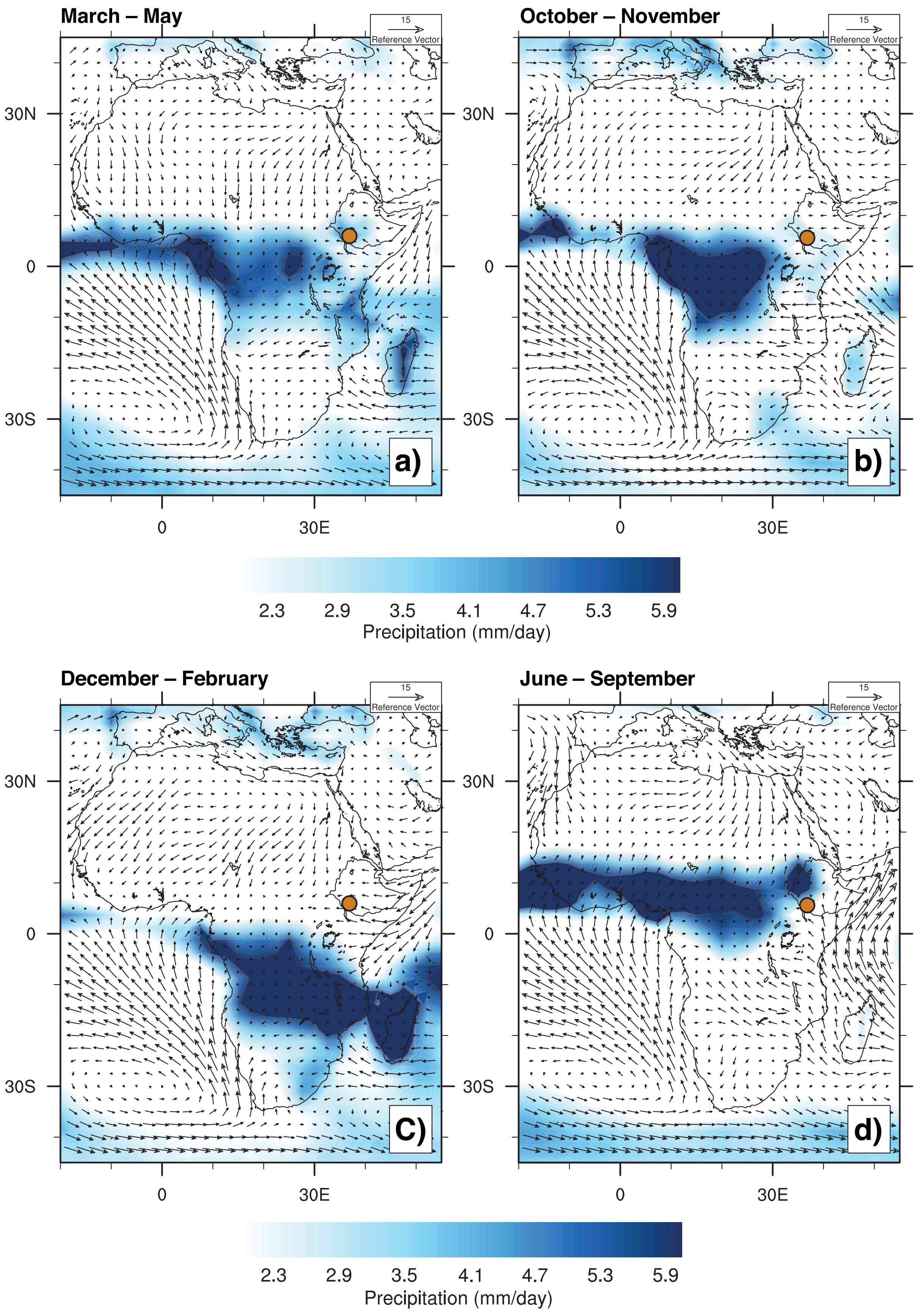
The hydroclimate of the Chew Bahir basin today is characterized by two alternating wet and dry seasons (Supplementary Figure S1): higher precipitation generally occurs in springtime (Mar-Mai) and autumn (Oct-Nov) [1 2 3] adding up to about 400–500 mm mean-annual precipitation. The pronounced seasonality is the result of the seasonal migration of the tropical rain belt, following the sun in its zenithal position with a delay of 3–4 weeks. Within this tropical rain belt multiple individual mesoscale convective systems (MCSs) can develop due to intense insolation, forming big cumulonimbus-type clouds. Those MCSs are responsible for most of the precipitation in eastern Africa and are linked to wave activity in the upper troposphere as well as to upper level jet streams [3]. However, this complex link between rainfall, MCSs and insolation fuel the yearly monsoon activity in eastern Africa. On longer time scales variations in mean-annual precipitation is controlled by changes in the Earth's orbital parameters (mainly eccentricity and precession), which in turn control variations in local insolation.

Another important factor of spatio-temporal humidity variations over Ethiopia is its topography. In combination with the temperatures over the western Indian Ocean, the complex terrain of the area determines the occurrence and strength of the Turkana Jet transporting air masses inland [3 4]. Due to divergence effects over the coast of Somalia, these air masses lose their moisture further inland. But in general, the vicinity of the Indian Ocean as the main moisture source for Chew Bahir documents the importance of (1) sea surface temperatures (SSTs) of that water body, because warmer ocean waters enhance the evaporation and the amount of water in the troposphere, and (2) the air circulation over tropical eastern Africa and the Indian Ocean (i.e. the Walker Circulation). Both depend on the Indian Ocean Dipole (IOD), an anomaly of the SSTs between the western and eastern Indic [5]. A positive IOD anomaly with lower SSTs in the eastern sector of the Indic (close to Australia and Indonesia) and higher SSTs at the eastern African coast, triggers more precipitation in tropical eastern Africa [3].

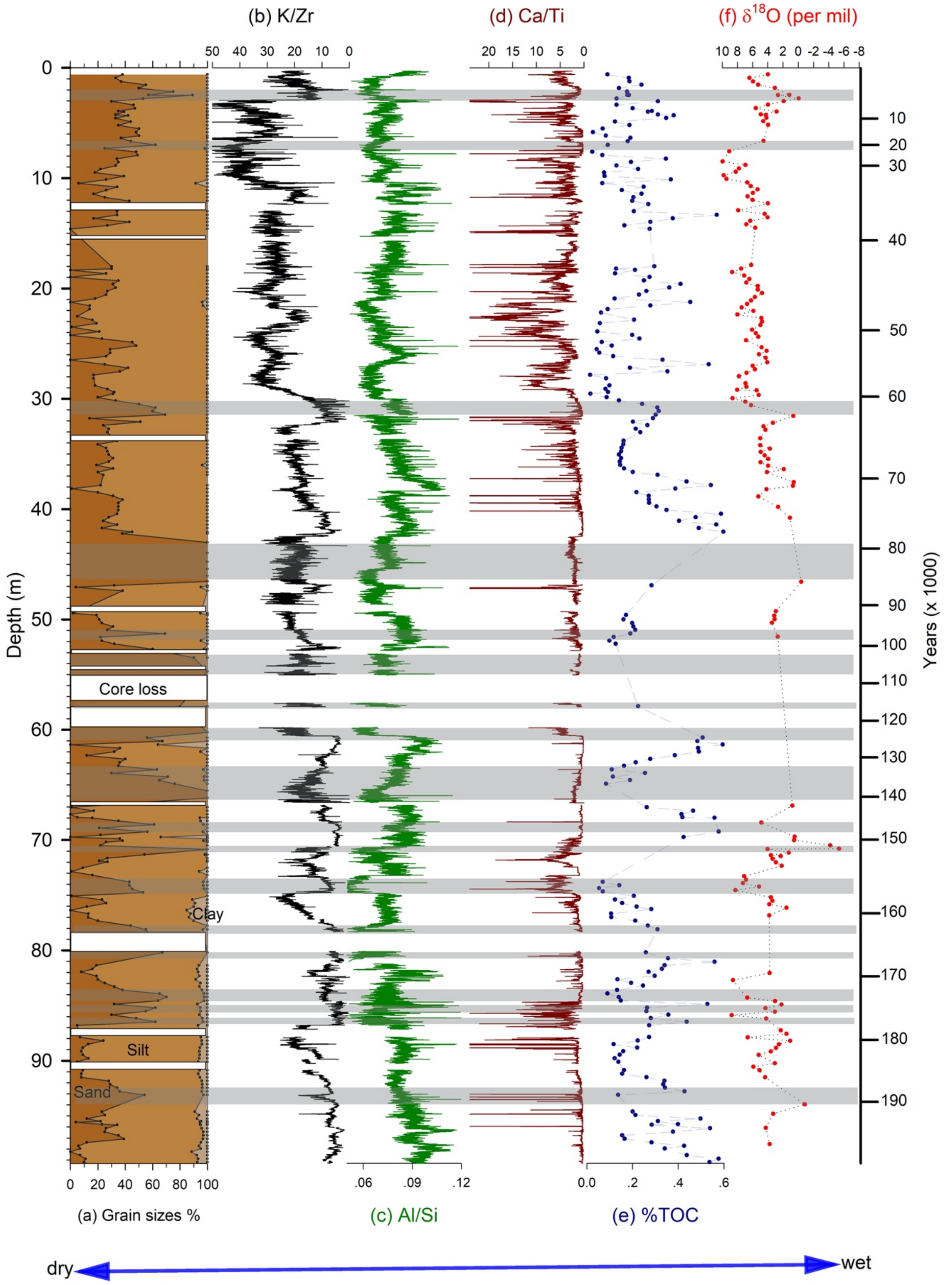
Supplementary Note 2 for Tectonics, topography and geology

Chew Bahir (Fig. 1) is a playa lake located in a ~40 km wide and ~90 km long tectonic basin in the southern Main Ethiopian Rift (sMER), bounded by the Hammar range (up to 1500 m asl) from the west and the Teltele Plateau (up to 2000 m asl) from the east [6]. The tectonic development of the rift which started during the early Miocene [7] led to the low elevation watersheds between the adjacent rift lakes and the more than 32,000 km^2 catchment area of the recent Chew Bahir basin. Since Chew Bahir has been classified as a failed rift, the tectonic influence of on the CHB signal within the analysed timeframe here is been negligible [8]. The lithology of the catchment is dominated by Proterozoic gneisses and granites in the west, while in the eastern sector is dominantly underlain by Miocene basalts [9].

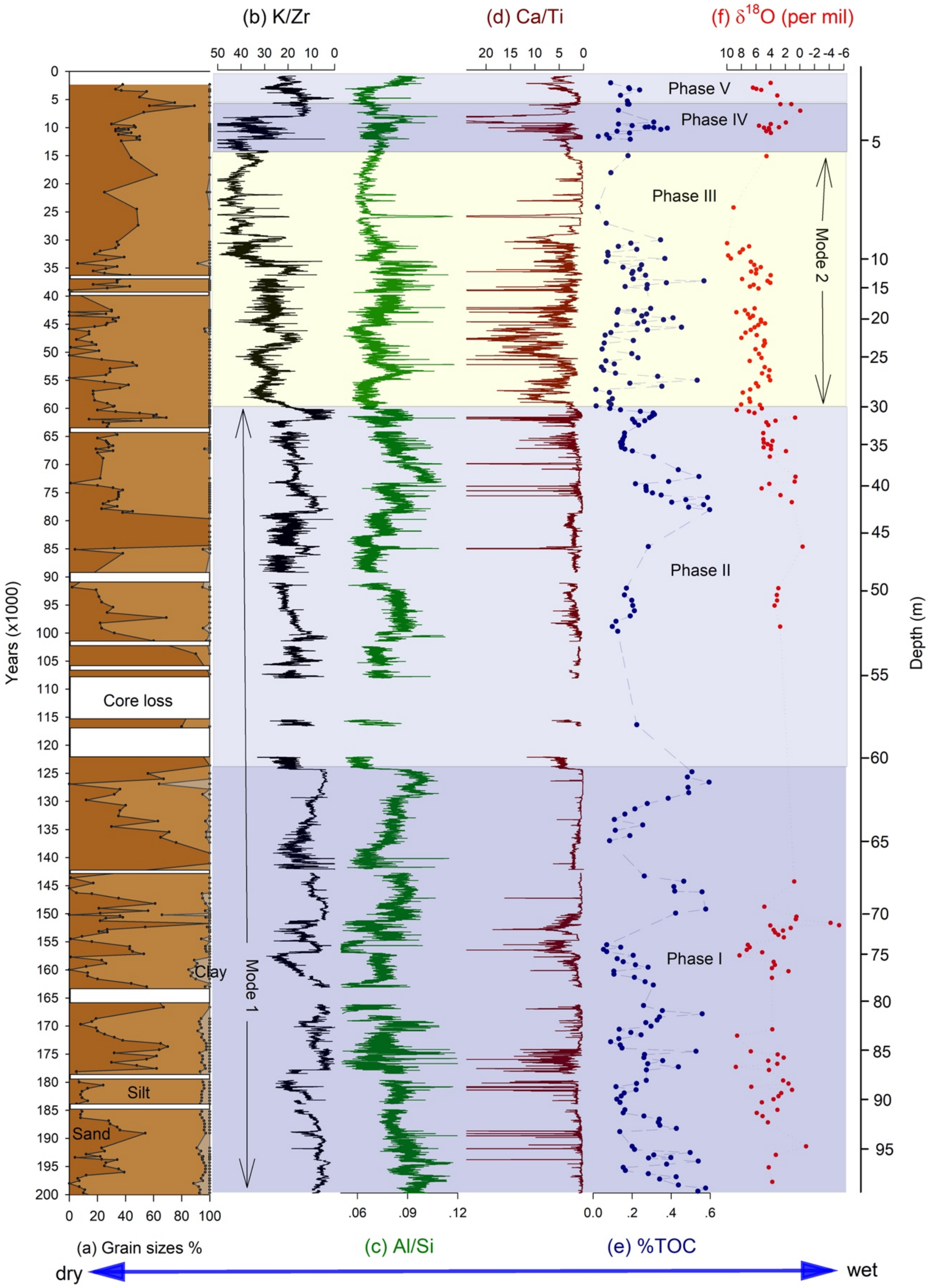
Supplementary Figures S1 to S5



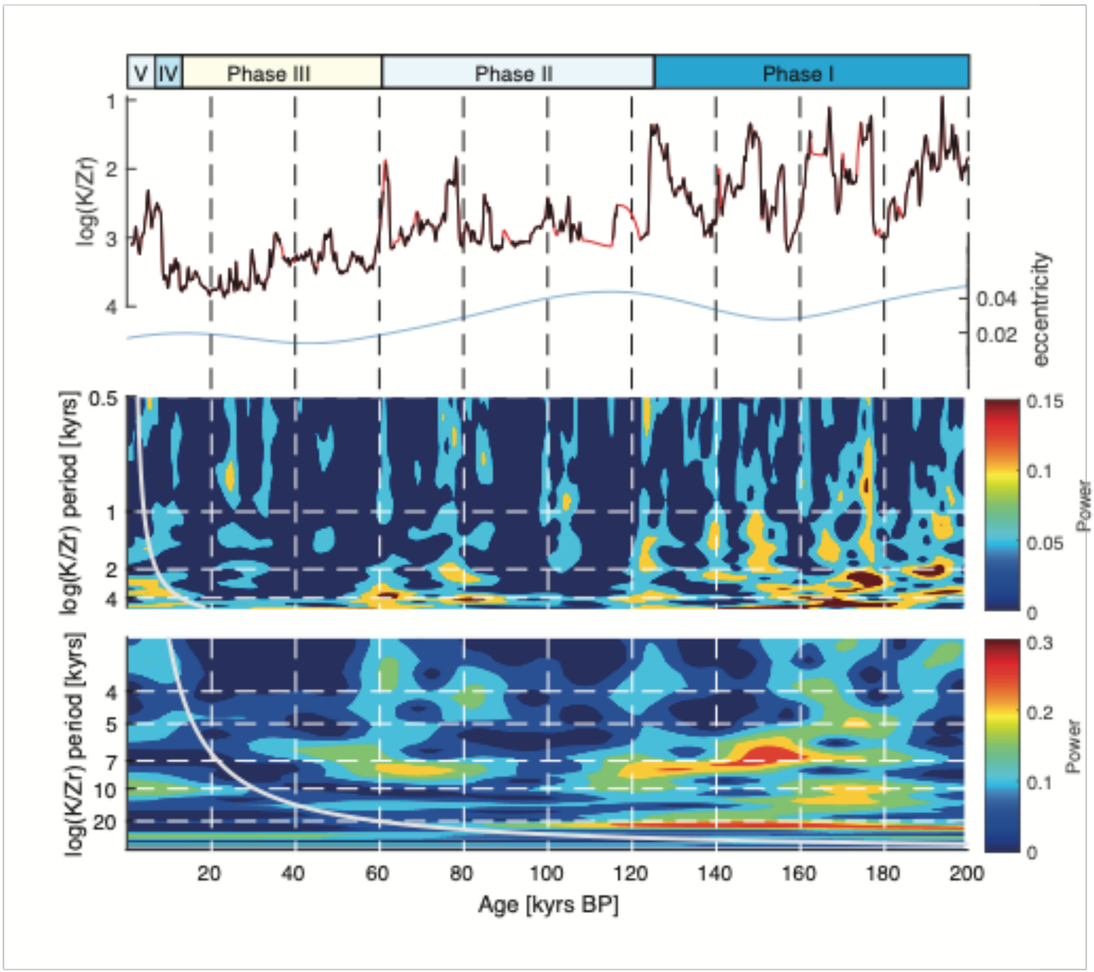
Supplementary Figure S1. Precipitation (mm/day), wind strength and direction during a) Mar–May (rainy), b) Oct–Nov (rainy), c) Dec–Feb (dry), d) Jun–Sep (dry), based on GPCC precipitation data provided by NOAA/OAR/ESRL PSD, edited by the help of D. Gebregiorgis (see https://www.esrl.noaa.gov/psd/). Brown point = Chew Bahir location.



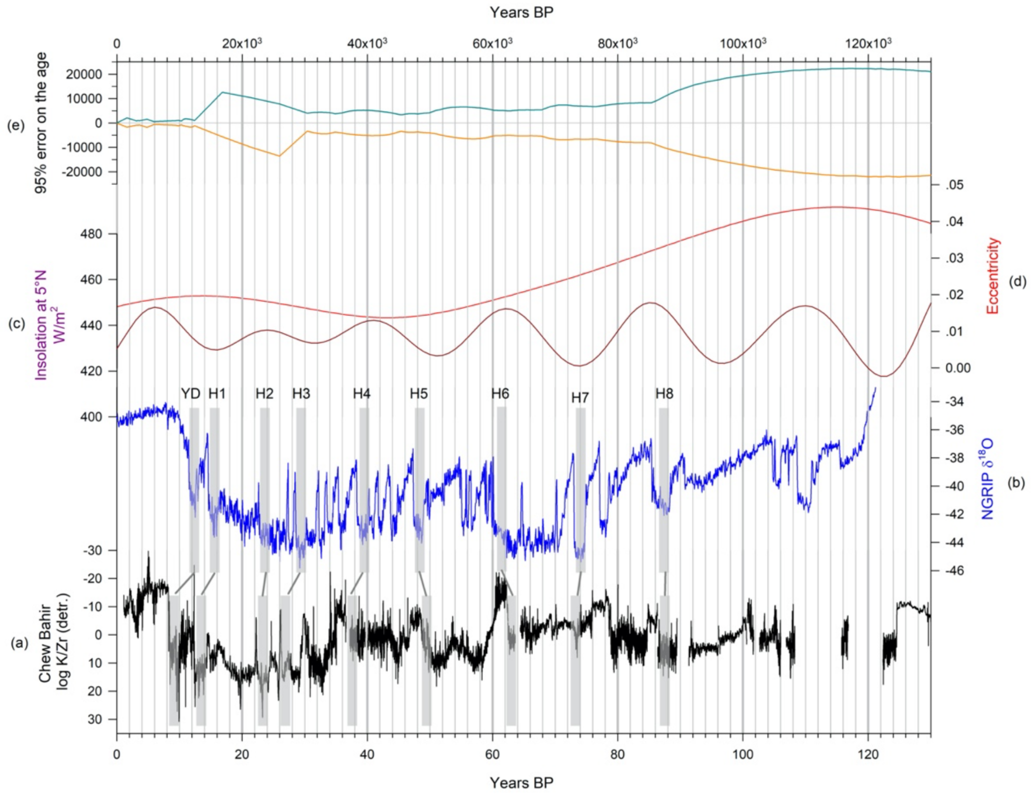
Supplementary Figure S2. Chew Bahir key climate proxies plotted against depth (left side scale composite core, uppermost ~100 m) with interpolated age scale (right side scale); age model based on [10]. (a) Grain sizes in %; (b) K/Zr (c) Al/Si; (d) Ca/Ti; (e) %TOC; (f) δ^{18o} (per mil). Grey bars indicate very prominent coarse grain layers, corresponding to generally wetter phases with lower K/Zr ratios, higher Al/Si ratios, lower Ca/Ti ratios, higher TOC values, negative δ^{18}O ratios; whitish bars in grain size column indicate core loss (bigger than 0.2 m).



Supplementary Figure S3. Chew Bahir key climate proxies plotted against age (left side), age model based on [10] and interpolated depth scale (right side scale composite core, uppermost ~100 m). (a) Grain sizes in %; (b) K/Zr (c) Al/Si; (d) Ca/Ti; (e) %TOC; (f) δ^{18o} (per mil). Included are climate phases I-V and climate modes.



Supplementary Figure S4. Results of wavelet power spectral analysis of the log(K/Zr) record from the Chew Bahir basin. The data were interpolated to an evenly spaced time axis and analyzed using continuous wavelet transformation (CWT) using the MATLAB function *cwt* contained in the Signal Processing Toolbox. We chose *Morlet* as the mother wavelet, which is very well suited to reproduce the cyclical characteristics of environmental variability in the Chew Bahir. The grey line marks the cone of influence which is used to mark the area where edge effects occur in the wavelet transformation.



Supplementary Figure S5. Correlation of the Chew Bahir logK/Zr (detr.) record (a) with the NGRIP record (b) [11]; Heinrich events are marked as grey, possibly corresponding to dry phases in the CHB. Uppermost panels: (c) Insolation at 5°N (W/m2) and (d) Eccentricity[10]; (e) 95% error on the age of the CHB sediment based on age modeling[11].

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